National Renewable Energy Laboratory
Innovation for Our Energy Future

New Needs for Visualization: Bulk Power System

Erik Ela

Erik.Ela@nrel.gov

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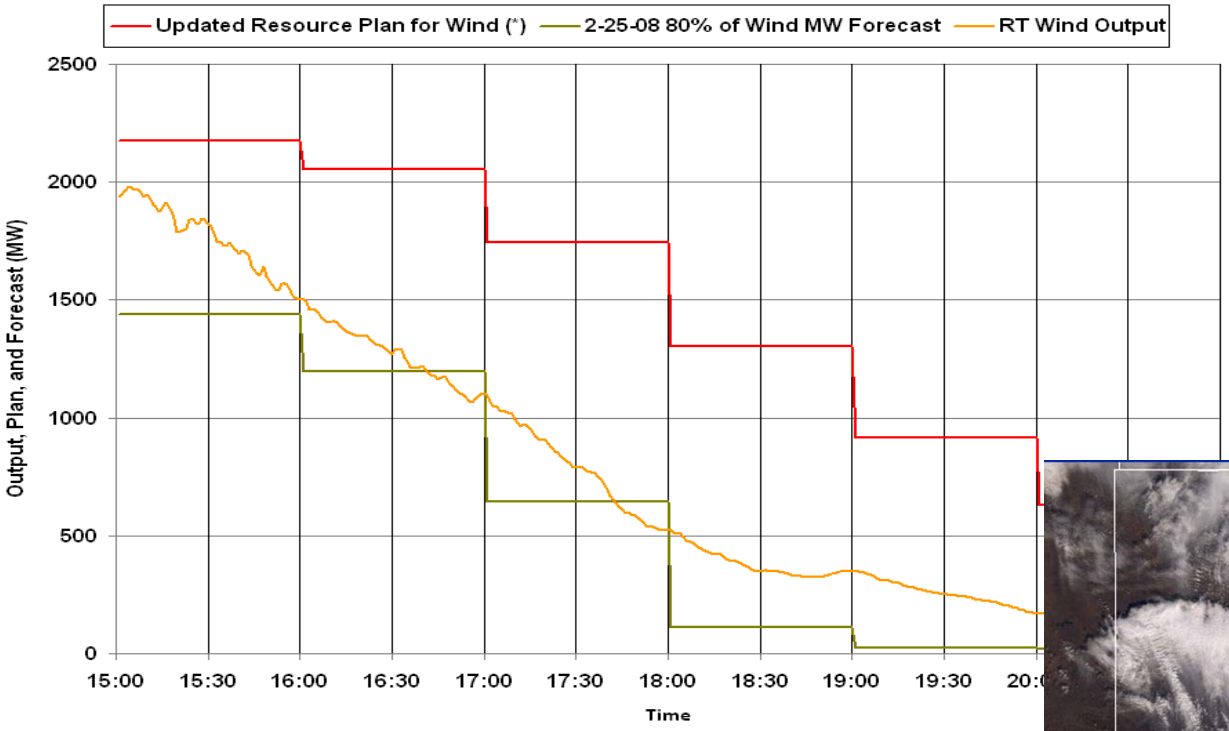
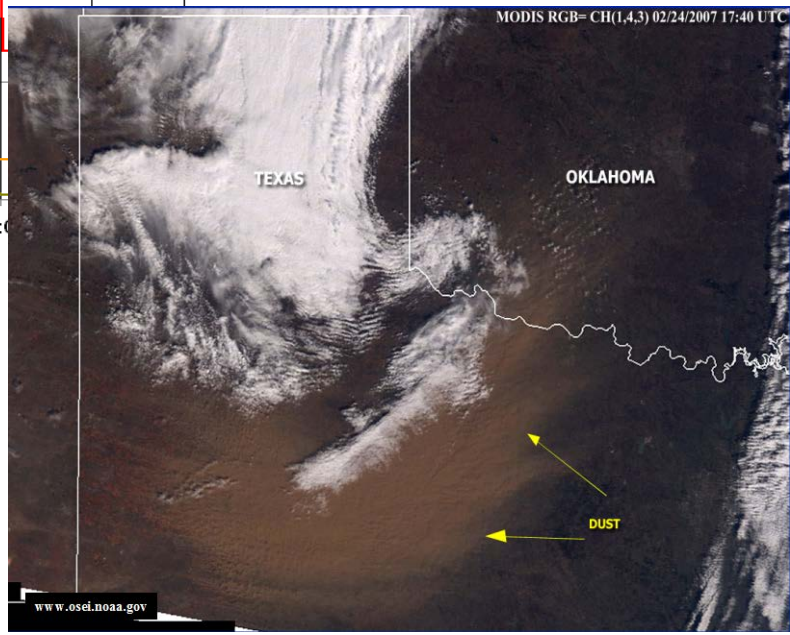
Times are a Changing…

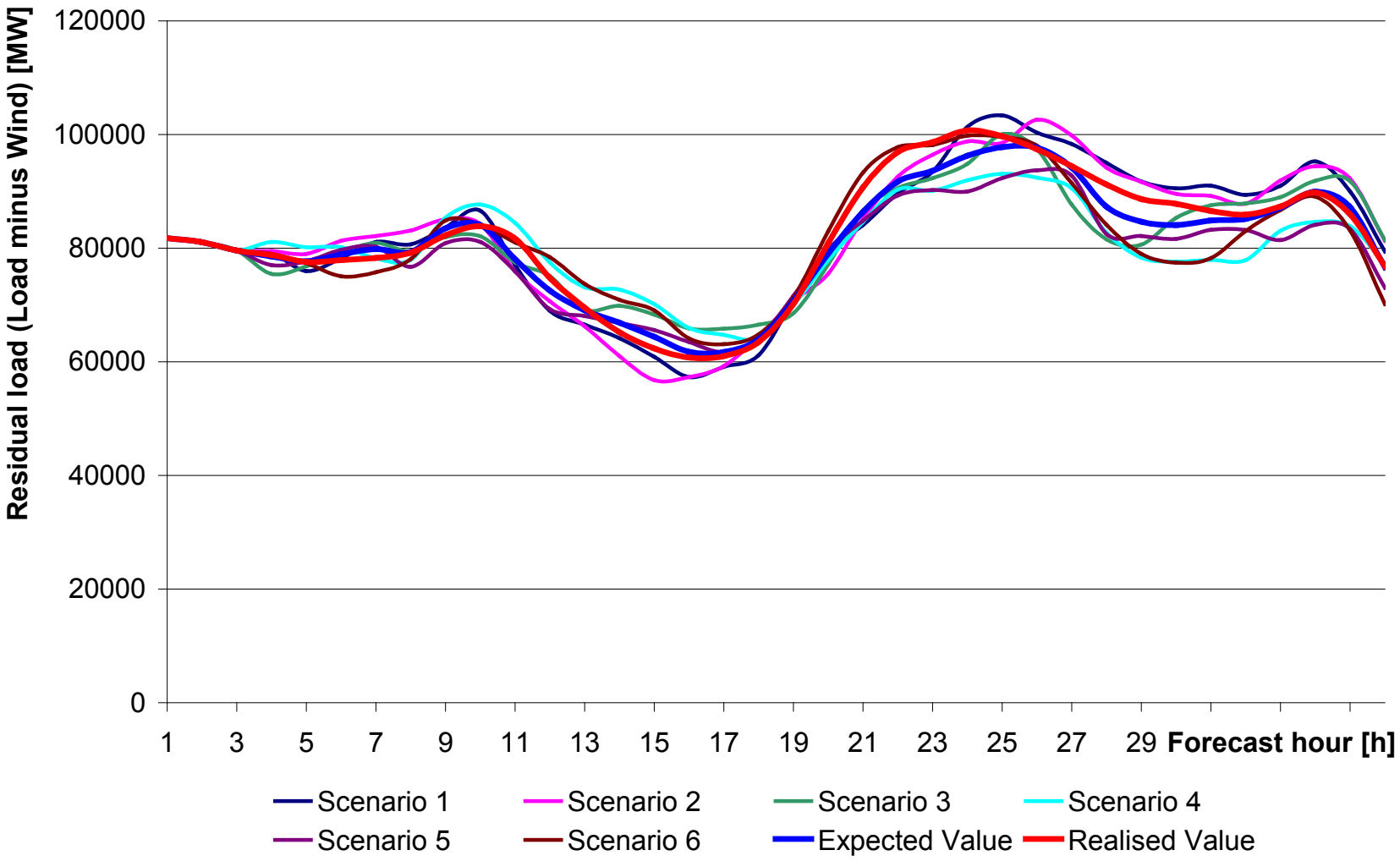
- Renewable Resources
- Responsive Demand
- Energy Storage Resources
- Enhanced Wide-Area Monitoring Technologies
- Increase of Generation behind the Transmission Meter
- Electricity Market Restructuring
- Increased communication/collaboration between balancing authorities

Resource Forecasts

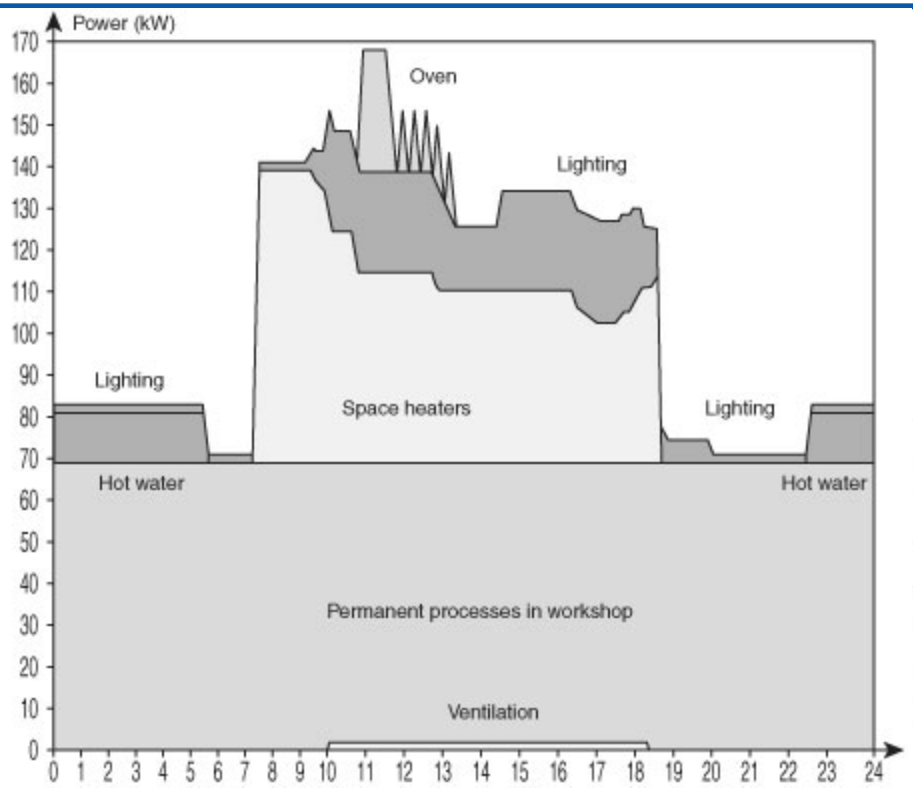




Information Overload

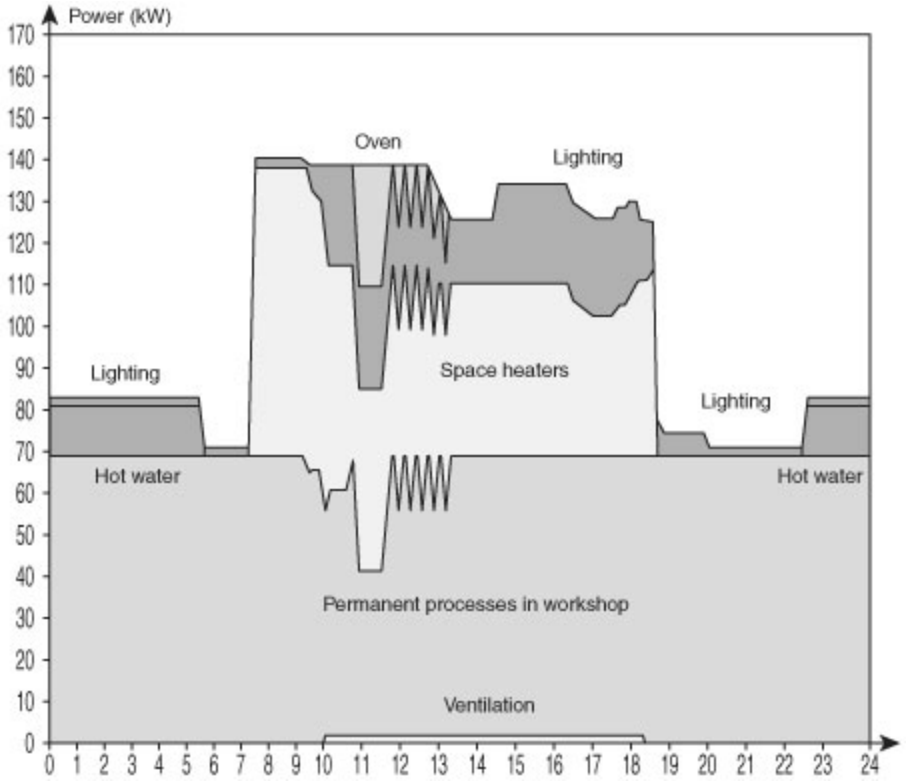


Demand Response



How does the TSO know what is going on?

How does the TSO know what is about to happen?



What data does the TSO need from the aggregator?

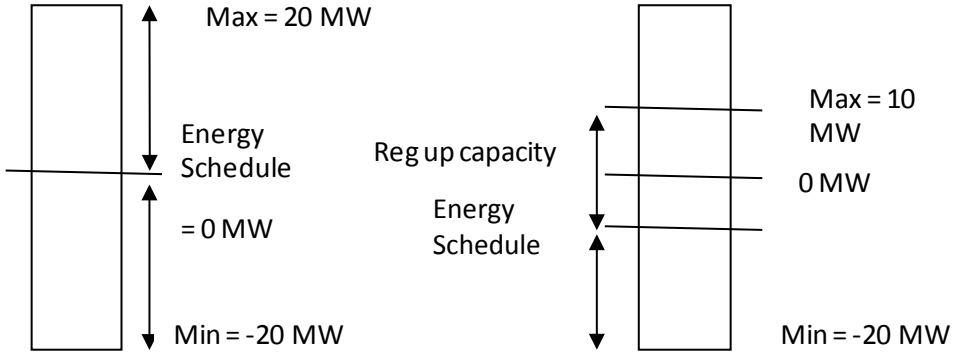
How can that data be presented to assist the TSO?

What is the level of detail?

Energy Storage

- Energy Storage can offer tremendous flexibility
- Parameters of operation are more complex
  - They can be a generator or a load
- Storage levels, optimal statuses, change times all have to be understood by system operator to operate efficiently.

Limited Energy Storage Dispatch



Normal operations

Low storage operations

PMU

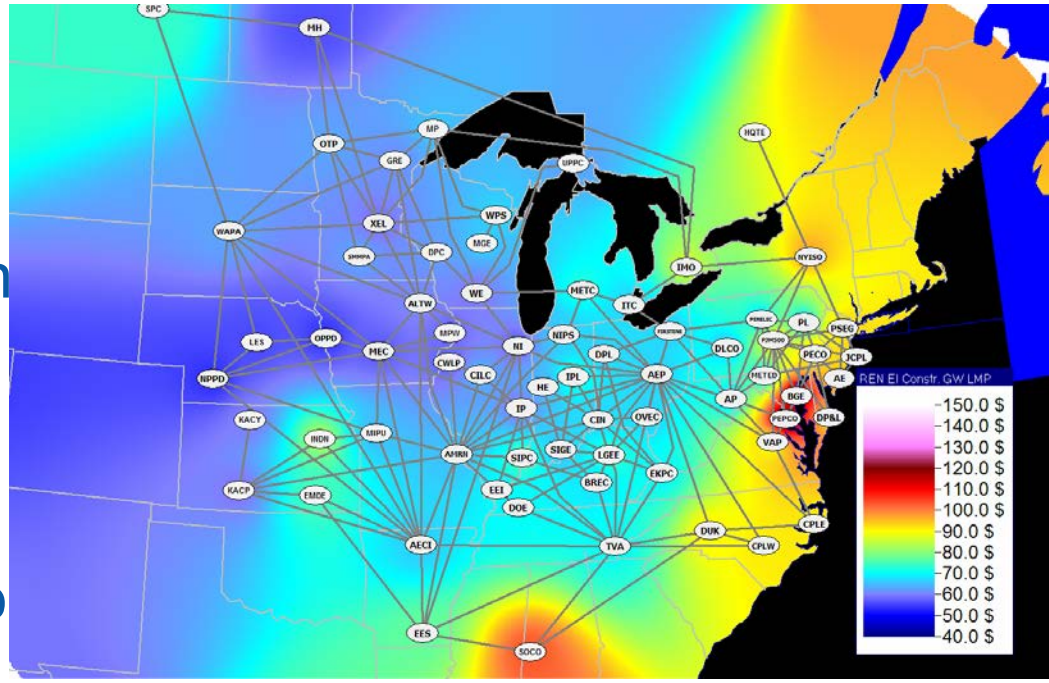
Other technologies are improving the monitoring of information on new geographical and temporal scales.

How can we display this information to ensure efficient usage without information overflow?

PMU Movie

Electricity Market Restructuring

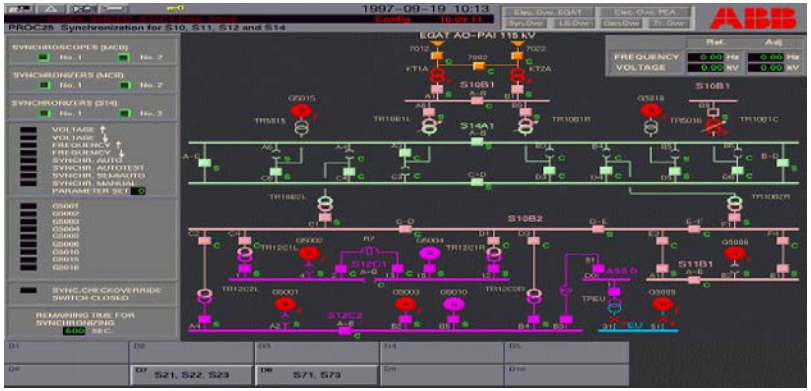
- Integration of market operations and power system operations becoming more critical
- What market information presented to system operator
- What system operations information presented to market operators?

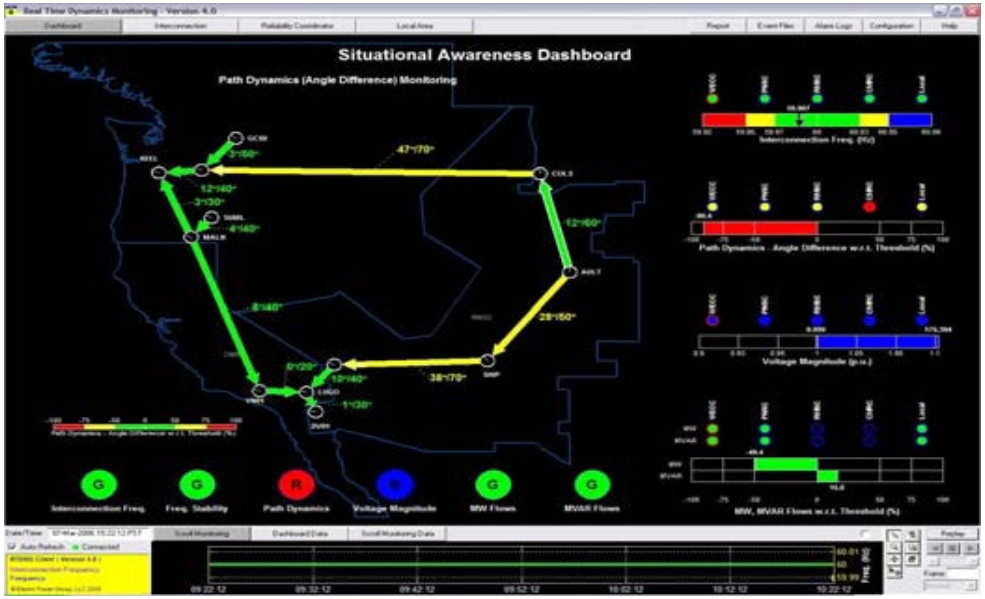


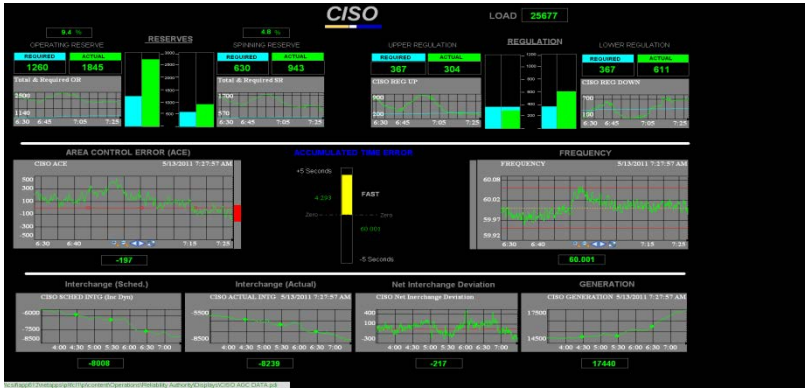
Analysis of Future Scenarios

http://rpm.nrel.gov/refhighre/expansion/expansion.html

Visualization in Control Room







Summary

- New technologies that are not fully understood yet are entering into the power system
- New technology means new data
- Data is often not fully understood yet, and there is potentially a lot of it
- Goals of this workshop:
  - What are the issues that current state-of-the-art is not addressing?
  - Of all of these issues, which are the most important?
  - How can facilities like ESIF, etc., be used to address these issues?